LESSON 5
CASING CONSTRUCTION

DRILLED SHAFT FOUNDATION INSPECTION

DECEMBER 2002

LESSON 5
CASED CONSTRUCTION METHOD
NOTES

LESSON 5

CASING CONSTRUCTION

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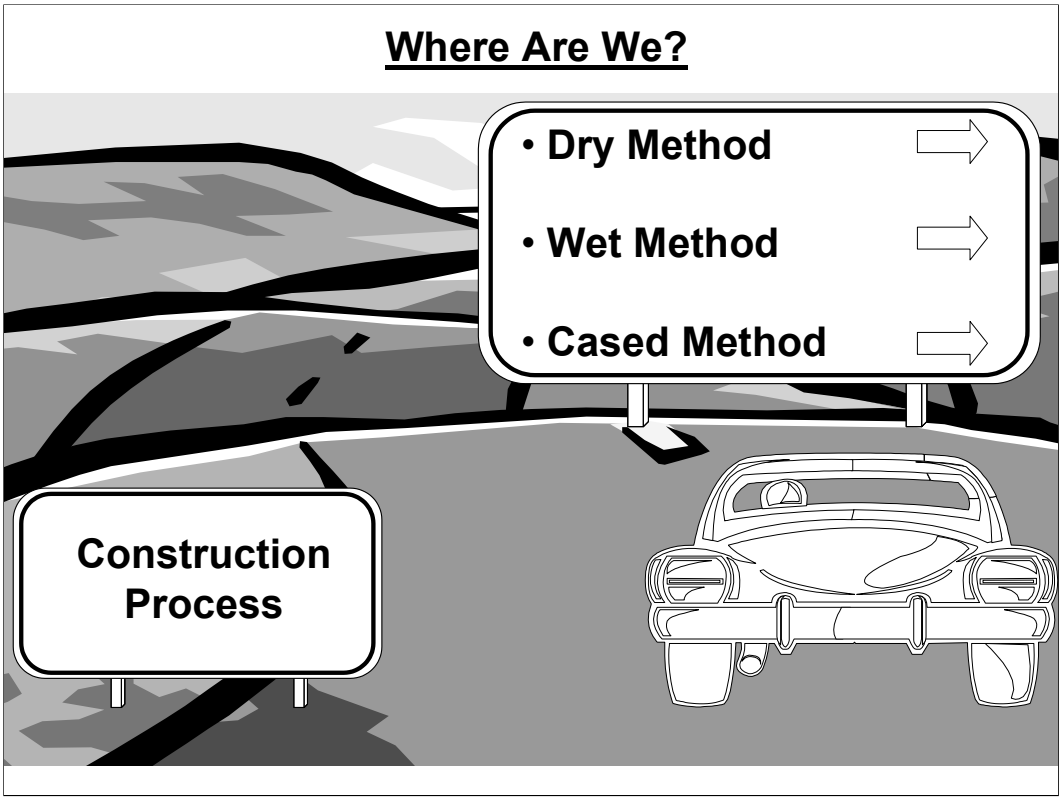
Where Are We?
• Dry Method
• Wet Method
• Cased Method
Construction Process

LEARNING OBJECTIVES

- **Explain why casing is used in both dry and wet holes**
- **Describe the cased shaft construction process**
- **Describe typical construction problems associated with the use of casing**

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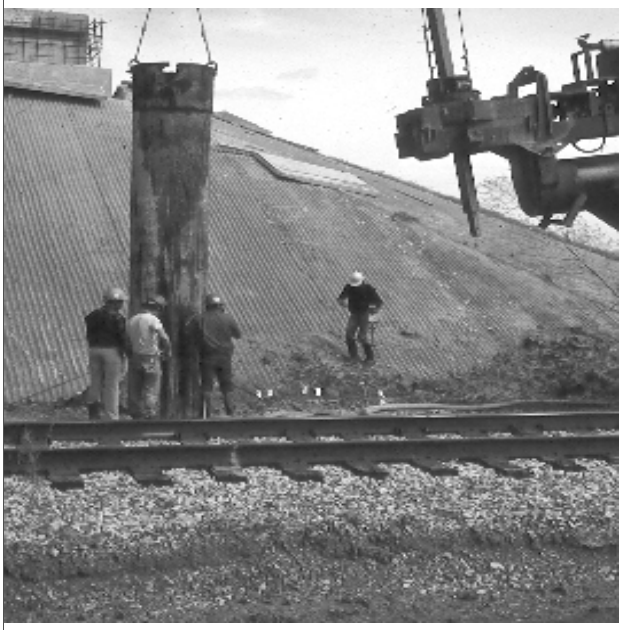
WHEN USED?



- Where an open hole **cannot** be maintained.
- Where soil or rock deformation will occur.
- Where constructing shafts below the water table or caving overburden.

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xxx.33 CASING CONSTRUCTION METHOD:

The casing method may be used either when shown on the plans or at sites when construction methods are inadequate to prevent hole caving or excessive deformation. In this method the casing may be either placed in a predrilled hole or advanced through the ground by twisting, driving or vibration before being cleaned out.

Casings and liners play an important role in the construction of drilled shafts, and special attention must be given to their selection and use.

Casings are tubes that are relatively strong, usually made of steel, and joined, if necessary, by welding.

Liners, on the other hand, are light in weight and become a permanent part of the foundation. Liners may be made of sheet metal, plastic, or pressed fibers (e.g., SonotubeTM). While their use is much less frequent than that of casings, liners can become important in some situations.

? SOMEWHAT MIS-NAMED ?

Though called a construction method, the Contractor is installing either wet or dry shafts, and casing is considered another tool by some.

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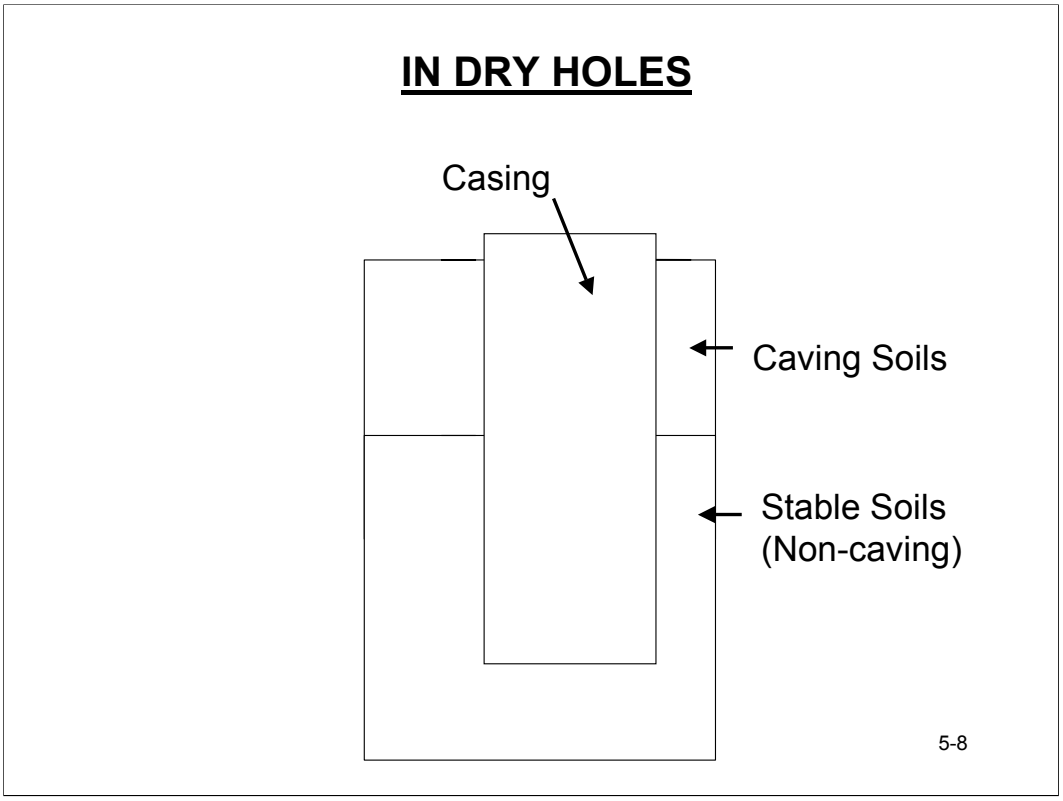

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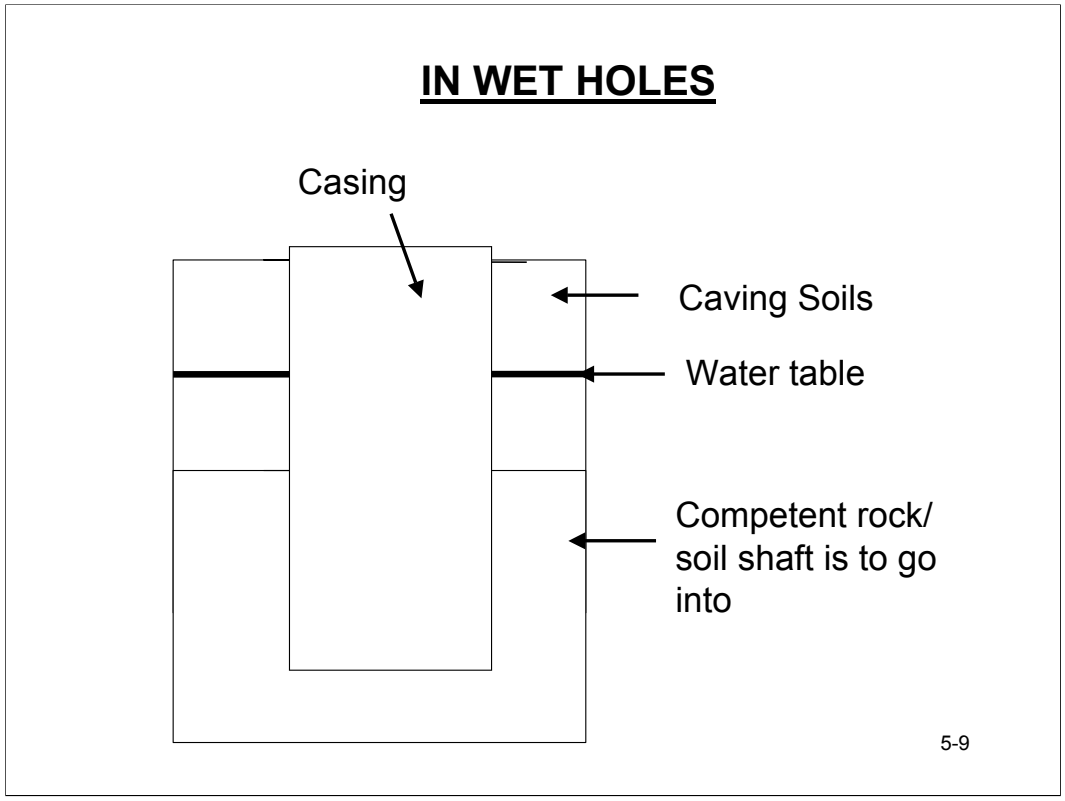
The most common scenario for the use of casing is construction in generally dry soils or rocks that are stable when they are cut but which will slough soon afterwards. In such a case the borehole is drilled, and casing (a simple steel pipe) is quickly set to prevent sloughing.



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Another notable example of a scenario in which casing could be used is a clean sand below the water table underlain by a layer of impermeable limestone or low permeability clay into which the drilled shaft will penetrate. In this case, since the overlying sand is water bearing, it is necessary to seal the bottom of the casing into the underlying rock/soil to prevent flow of water and caving of soils into the borehole.

LEARNING OBJECTIVE # 1

Explain why casing is used in both dry and wet holes.

Why is casing used in dry holes?

What are some reasons for casing in wet holes?

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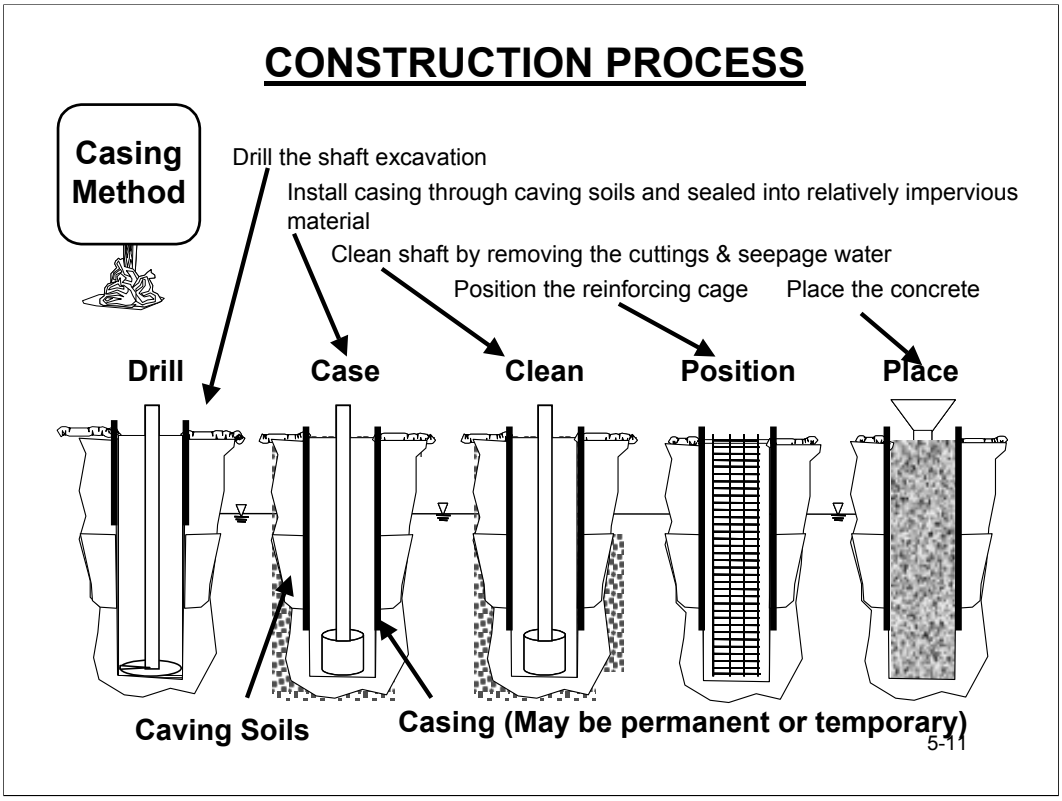
CONSTRUCTION PROCESS
Casing Method
Drill the shaft excavation
Install casing through caving soils and sealed into relatively impervious material
Clean shaft by removing the cuttings & seepage water
Position the reinforcing cage
Place the concrete
Drill
Case
Clean
Position
Place
Caving Soils
Casing (May be permanent or temporary)
5-11

THE CASING CONSTRUCTION PROCESS

Generally the casing method is more expensive and difficult than the dry construction method.

Key elements to quality cased holes are:

- Experienced Contractor
- Good casing material
- Experienced rig operator

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Temporary Casing

It is necessary in some construction procedures to seat a temporary casing into an impervious formation such as massive rock. This temporary casing is used to retain the sides of the borehole only long enough for the fluid concrete to be placed. The temporary casing remains in place until the concrete has been poured to a level sufficient to withstand ground and groundwater pressures. The casing is removed after the concrete is placed. Additional concrete is placed as the casing is being pulled to maintain the pressure balance. Thereafter, the fluid pressure of the concrete is assumed to provide borehole stability.

The wall thickness of temporary casing should be determined by the Contractor to ensure stability. Most casing is made of steel, and wall thicknesses usually vary from 0.5 inches (13 mm) upwards, with larger thickness for larger-diameter casings.

One of the most important uses of casing is to protect workers who must go into the borehole. In the picture above, workers have had to go down the hole to place a chain around a large boulder, which was then lifted to the surface. This is a temporary casing.

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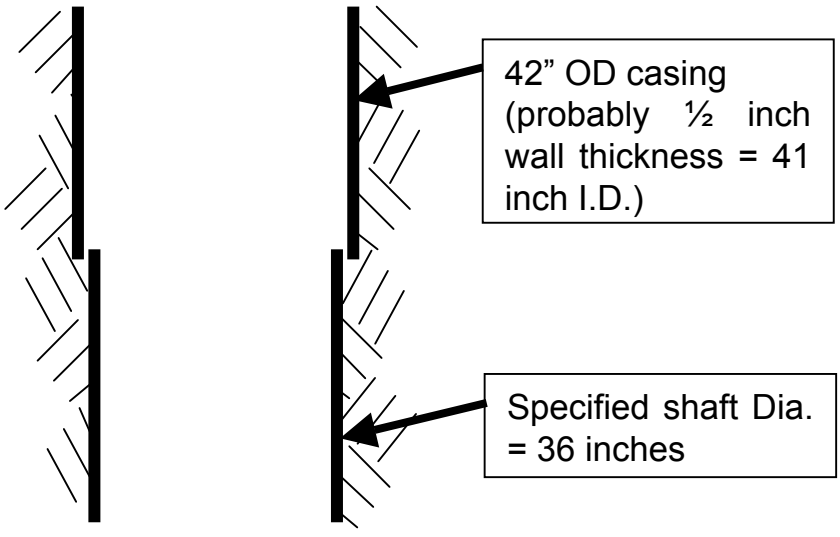
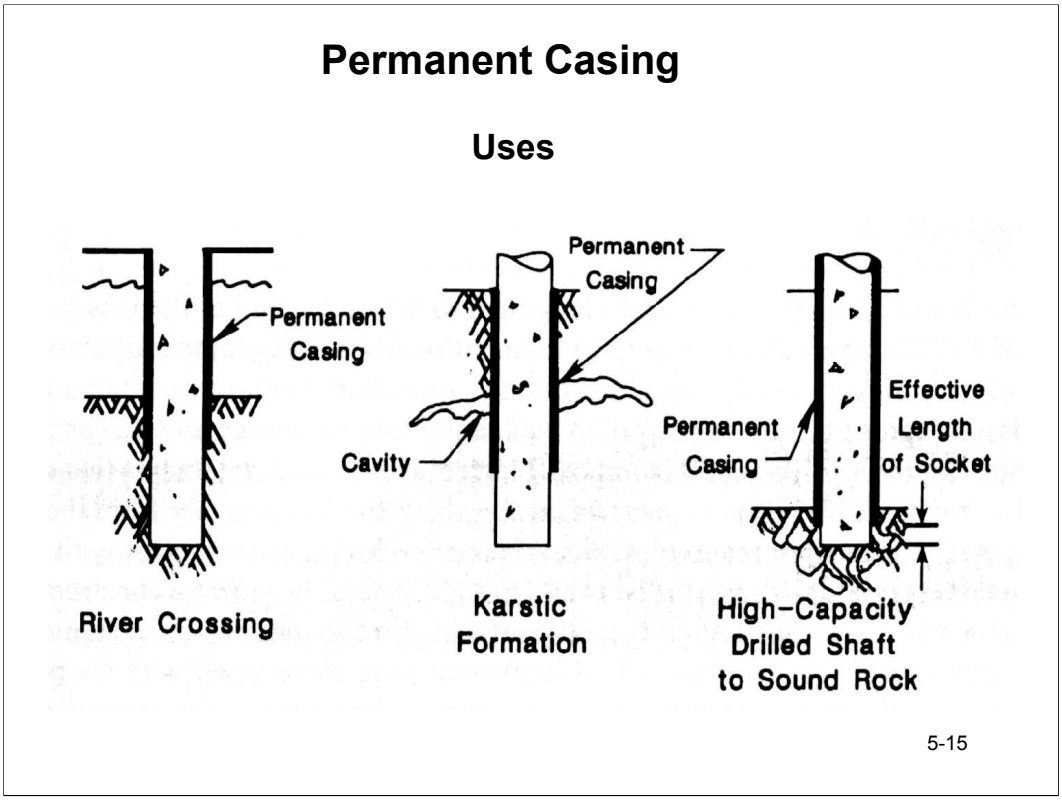
Most drilled shaft contractors keep a supply of temporary, reusable steel casing in their yard in a variety of lengths and diameters. Most casing is specified according to its outside diameter. If an inside diameter is specified, the Contractor may have to purchase new casing for the project, which would be costly.

Casing comes rolled in outside diameters of 30, 36, 42, 48, etc., inches. Most tools have similar diameters. So to drill a hole with a particular diameter below the casing the Contractor will likely need to use a casing 6 in. larger in OD than the hole diameter below the casing.





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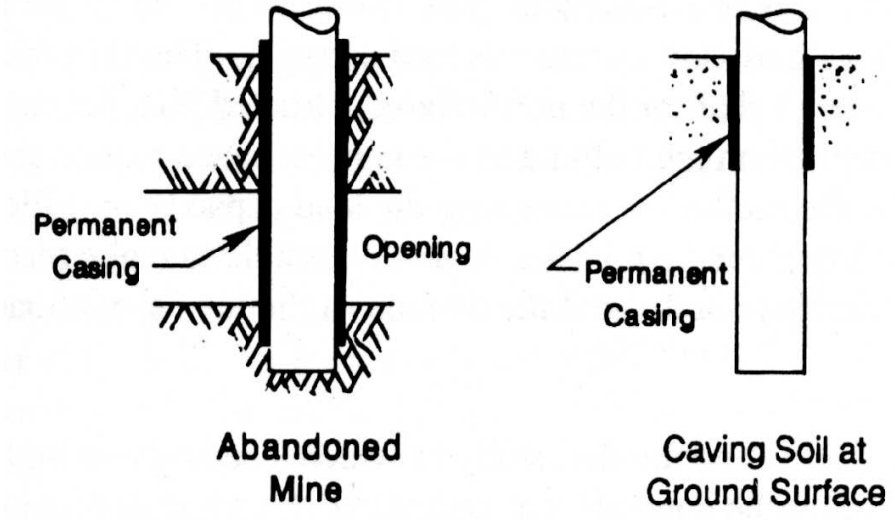
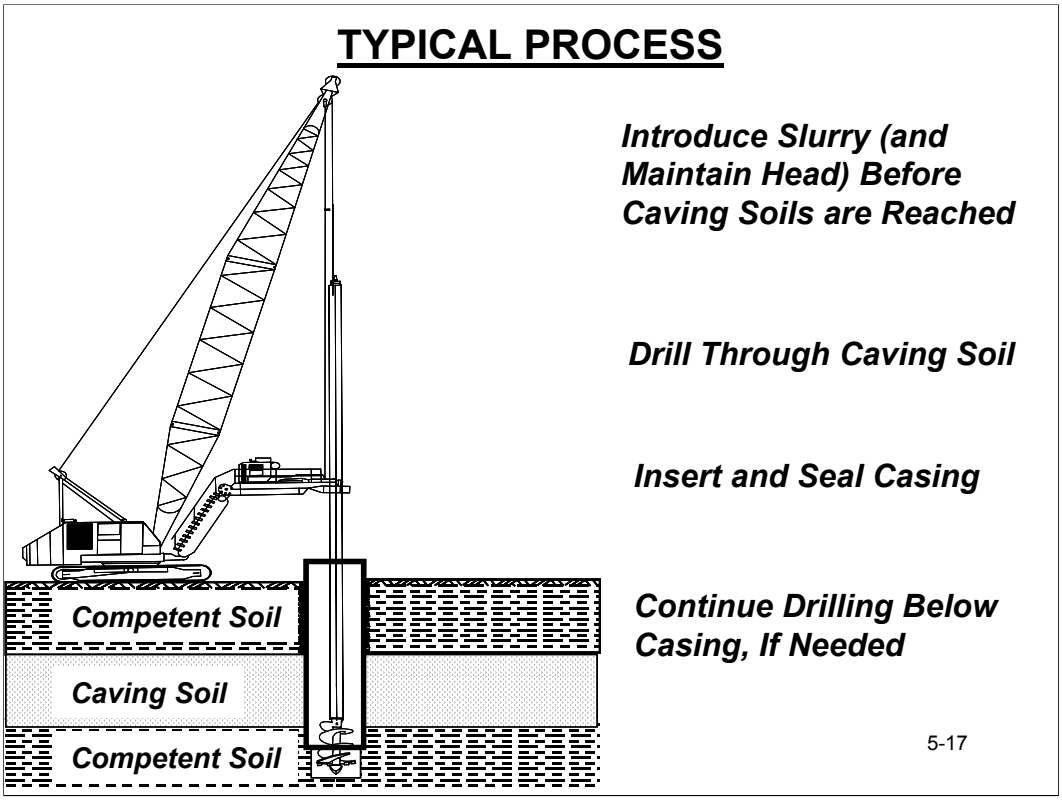
The use of permanent casing is implied by its name; the casing remains and becomes a permanent part of the foundation. An example of the use of permanent casing is when a drilled shaft is to be installed through water and the protruding portion of the casing is used as a form. A possible technique that has been used successfully is to set a template for positioning the drilled shaft, to set a permanent casing through the template with its top above the water and with its base set an appropriate distance below the mudline, to make the excavation with the use of drilling slurry, and to place the concrete through a tremie to the top of the casing. One possible objection to the use of such a technique is that the steel may corrode at the water level and become unsightly.

Permanent Casing Uses (Continued)





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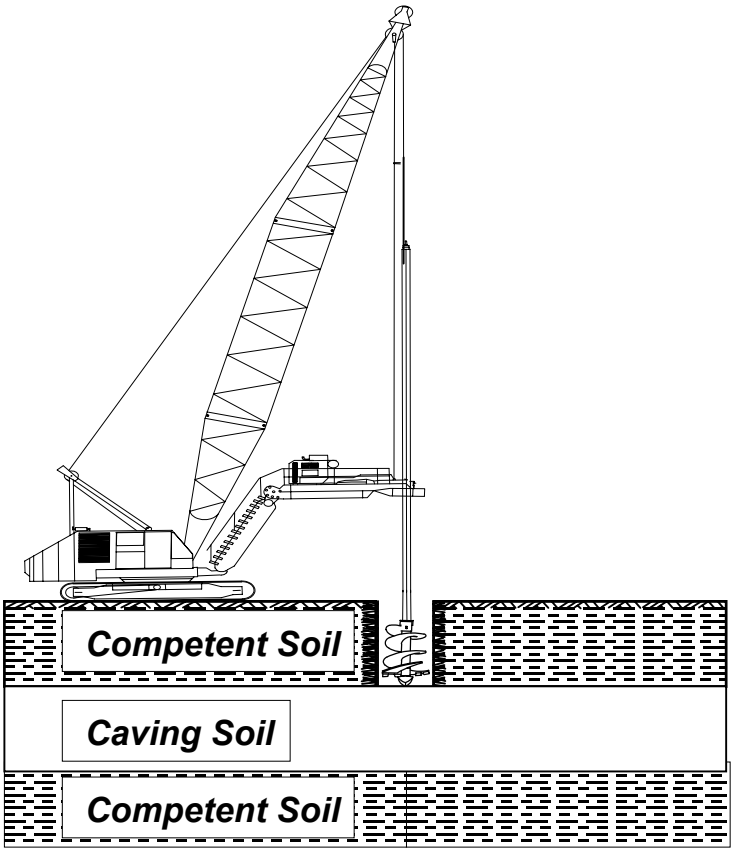
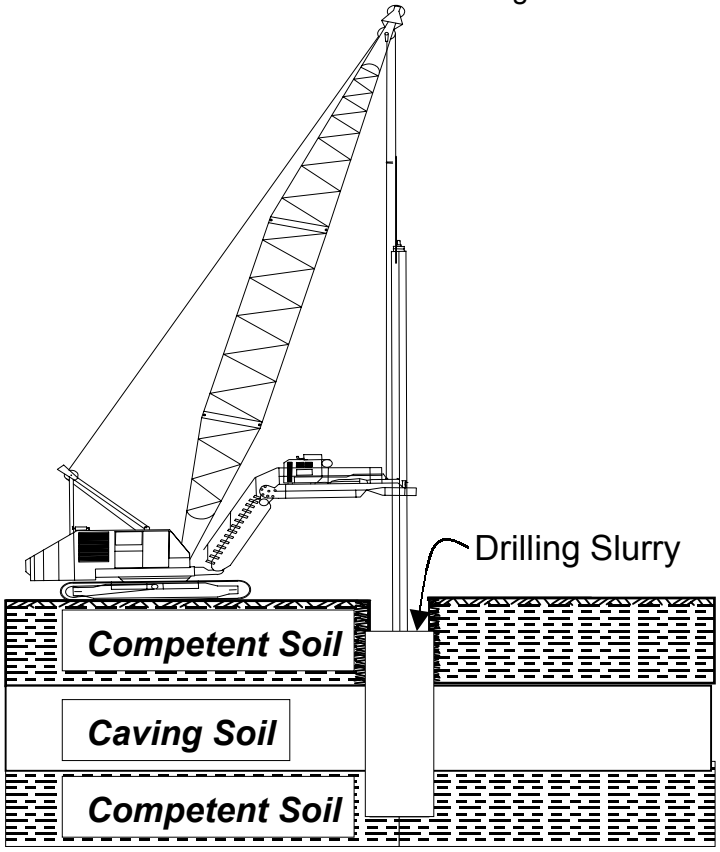
This is a common situation for casing construction. It is anticipated that casing will be used and the excavation through the zone to be cased proceeds until the caving soil is encountered, at which time slurry may be introduced into the borehole, and the excavation proceeds.

Drilling is continued until the stratum of caving soil is penetrated and a stratum of impermeable soil or rock is encountered.

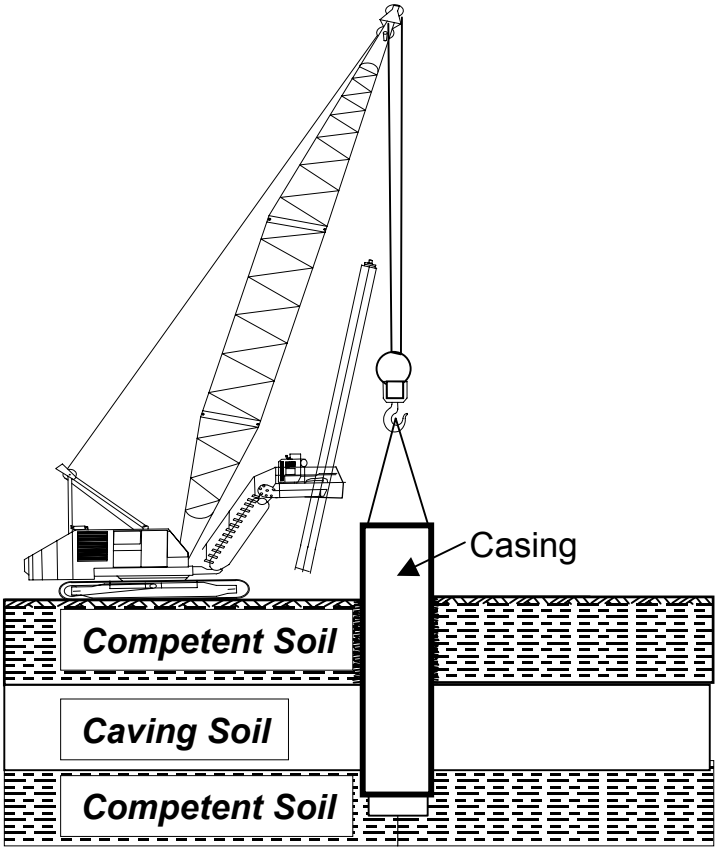
The casing is introduced at this point and is dropped, tapped, rotated, and/or pushed into the impermeable soil or rock a distance sufficient to effect a seal. The casing must be tight fitting to the walls of the hole. A bailing bucket or submersible pump may be used to clean the slurry from the casing. A smaller drill is introduced into the hole, one that will just pass through the casing, and the excavation is carried to the projected depth.



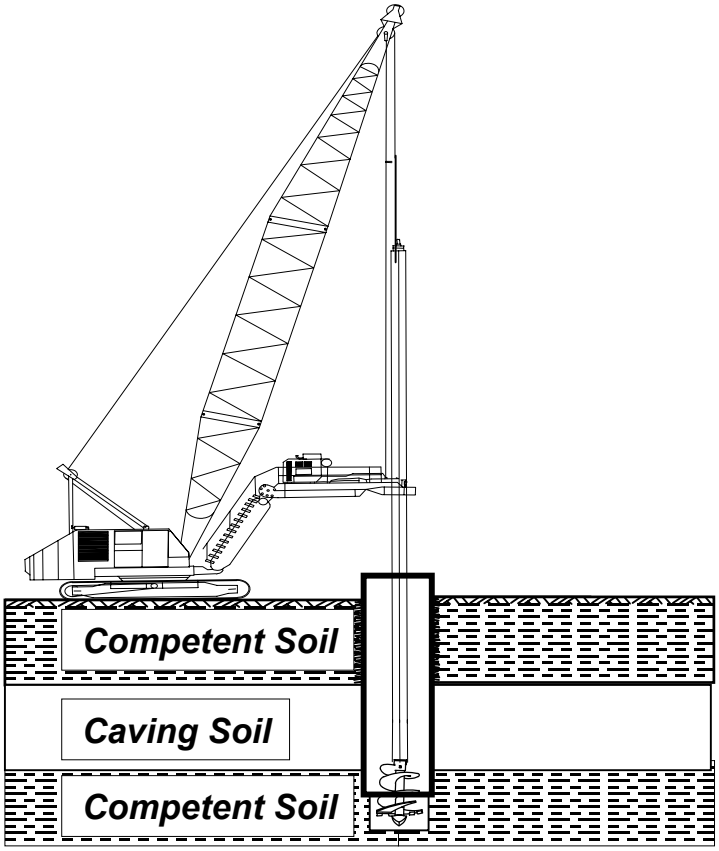
Introduce Slurry (and Maintain Head) Before Caving Soils are Reached



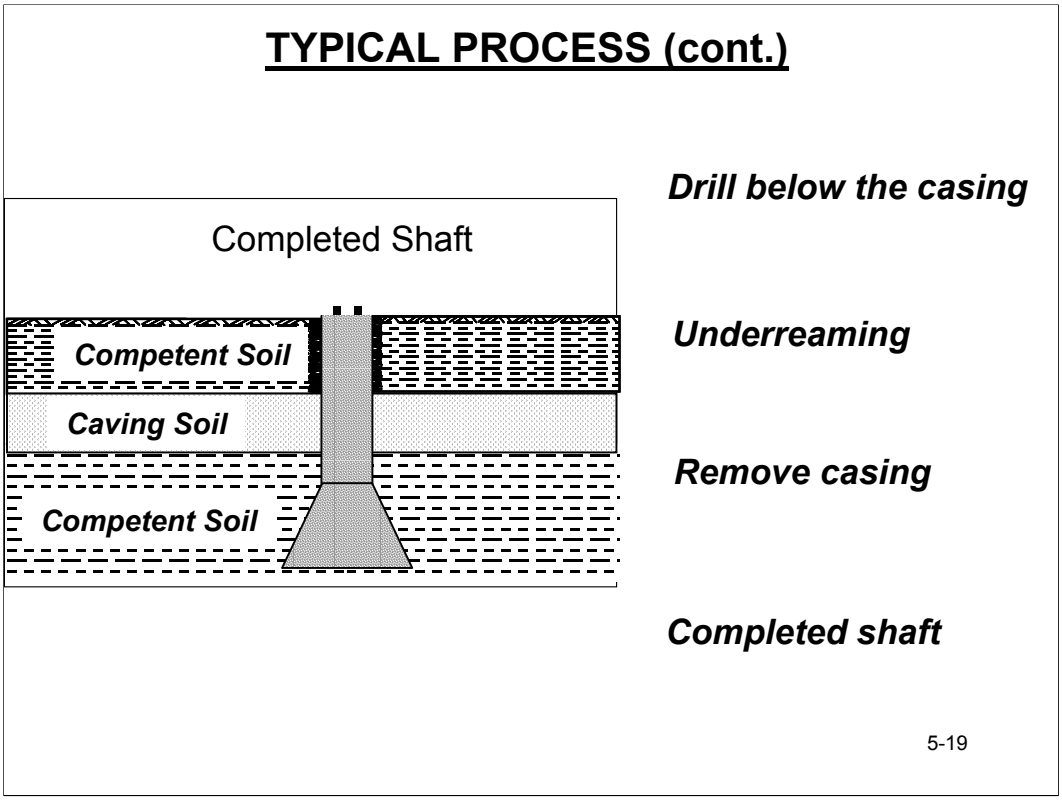
Drill Through Caving Soil



Insert and Seal Casing



Continue Drilling Below Casing, If Needed



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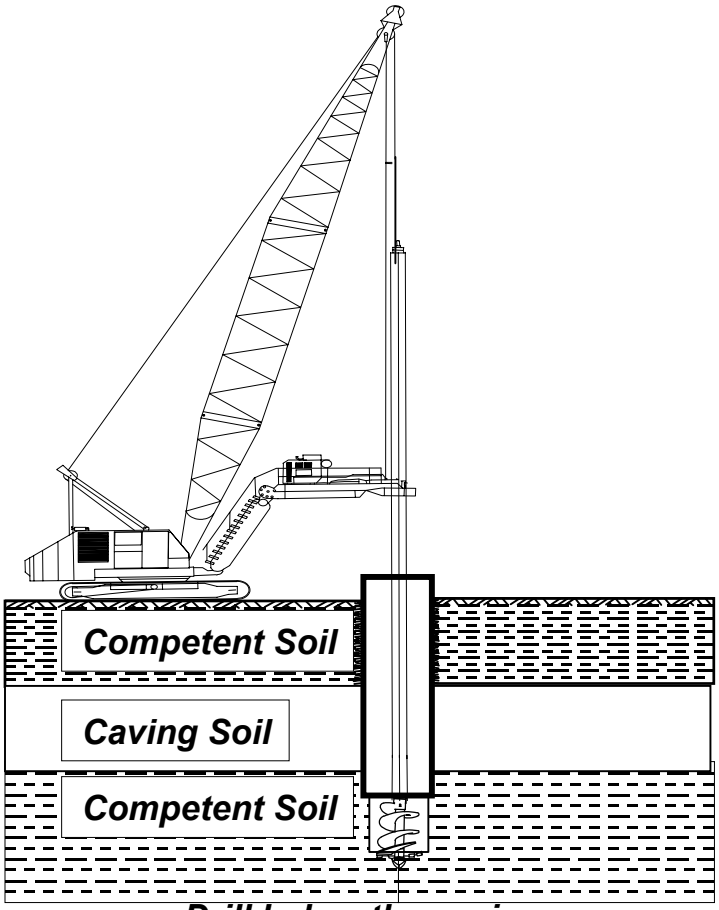
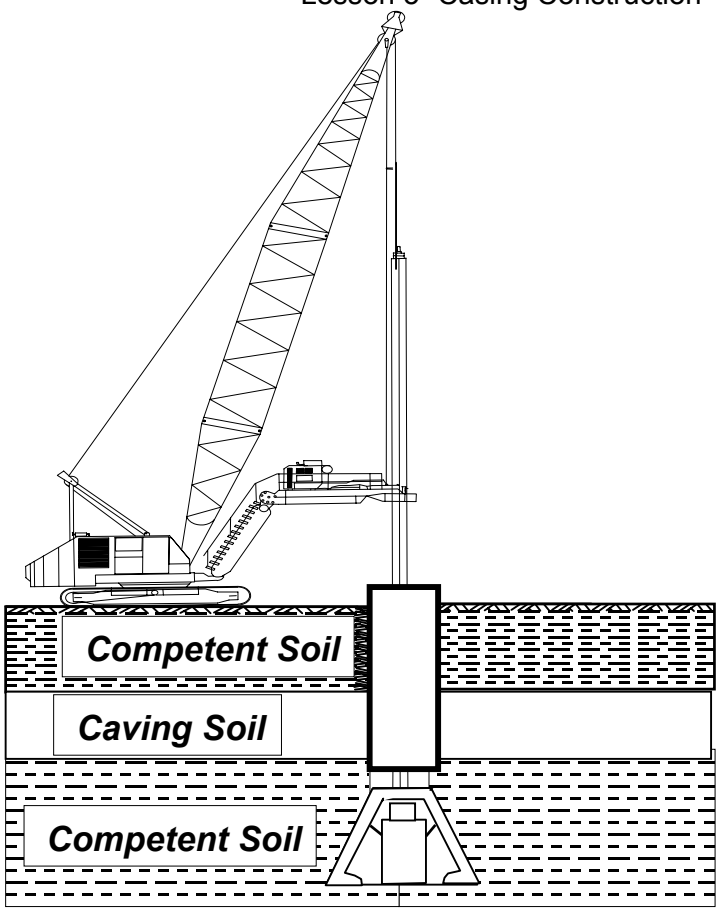
A belling tool can be placed on the kelly and the base of the drilled shaft can be enlarged.

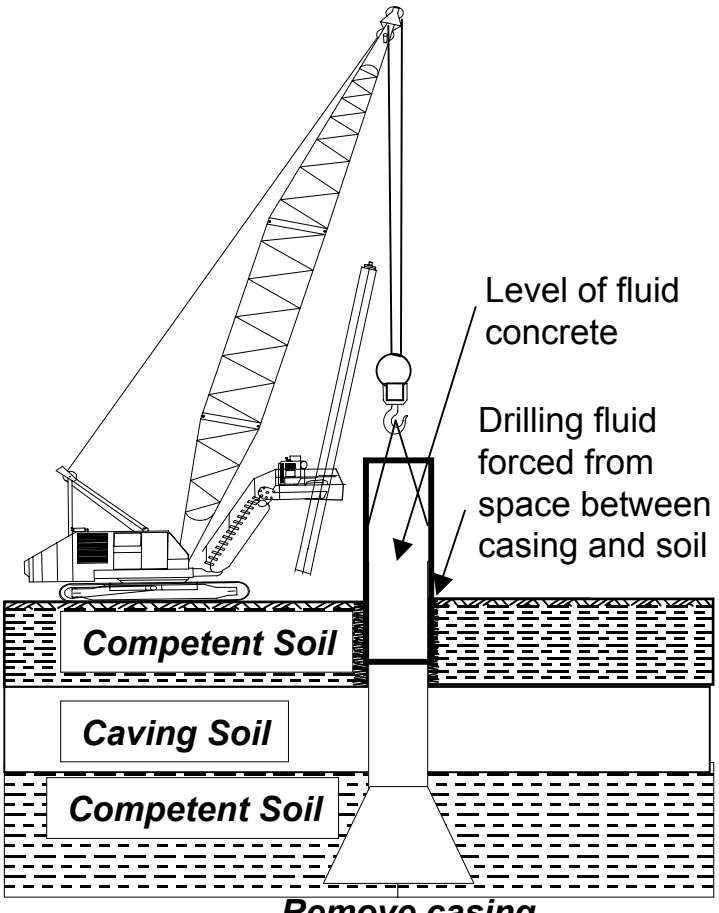
After any reinforcing steel has been placed, the hole should be completely filled with fresh concrete having good flow characteristics. Under no circumstances should the seal at the bottom of the casing be broken until the concrete produces a hydrostatic pressure greater than that of the fluid external to the casing (trapped slurry or ground water). The casing may be pulled and the seal broken when there is sufficient hydrostatic pressure in the column of concrete to lift the slurry that has been trapped behind the casing from the hole. The casing should be pulled slowly during the concrete placement to avoid “breaching” and trapping sediment or slurry in the concrete.



Drill below the casing

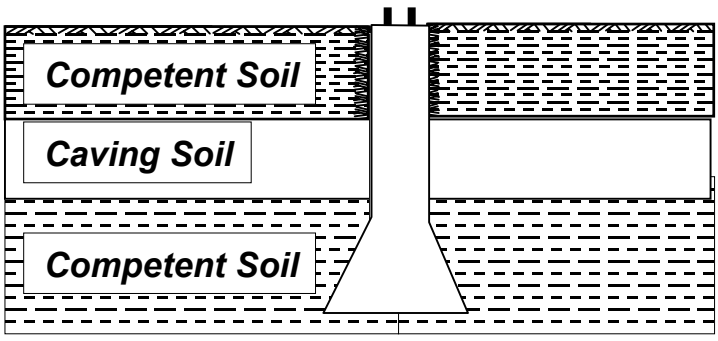


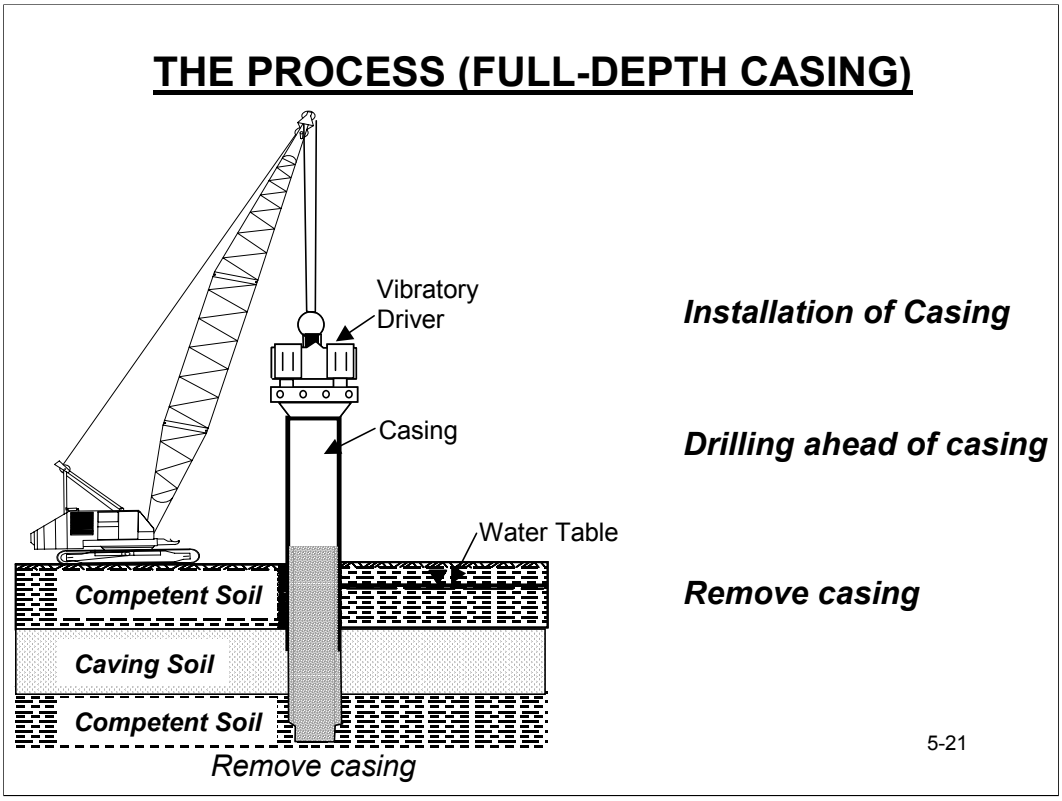
Underreaming



Remove casing

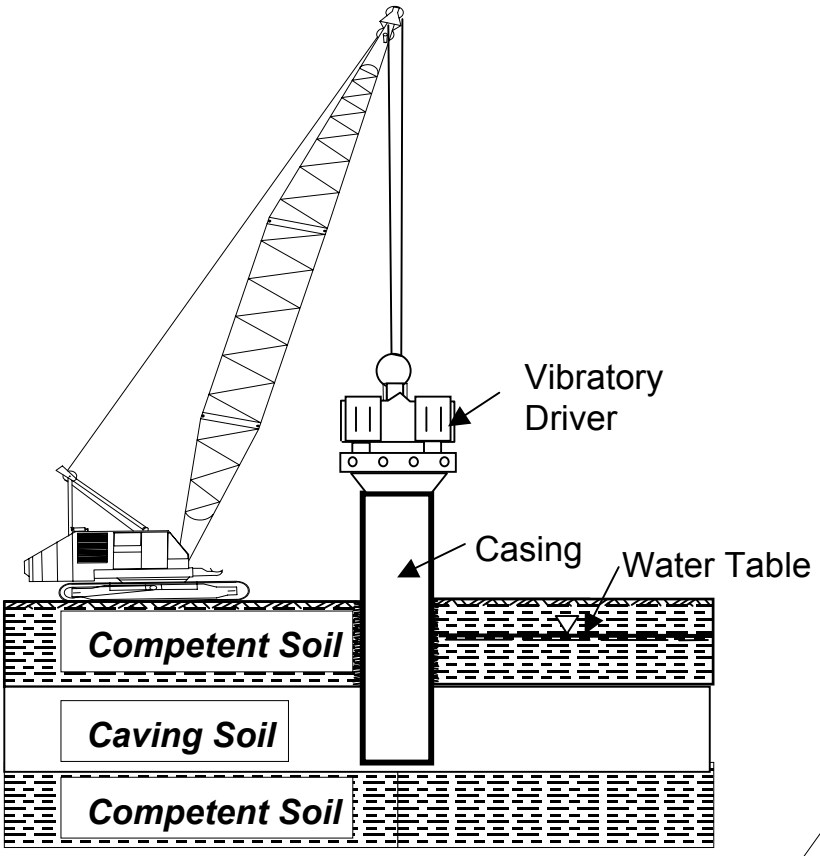
Completed shall



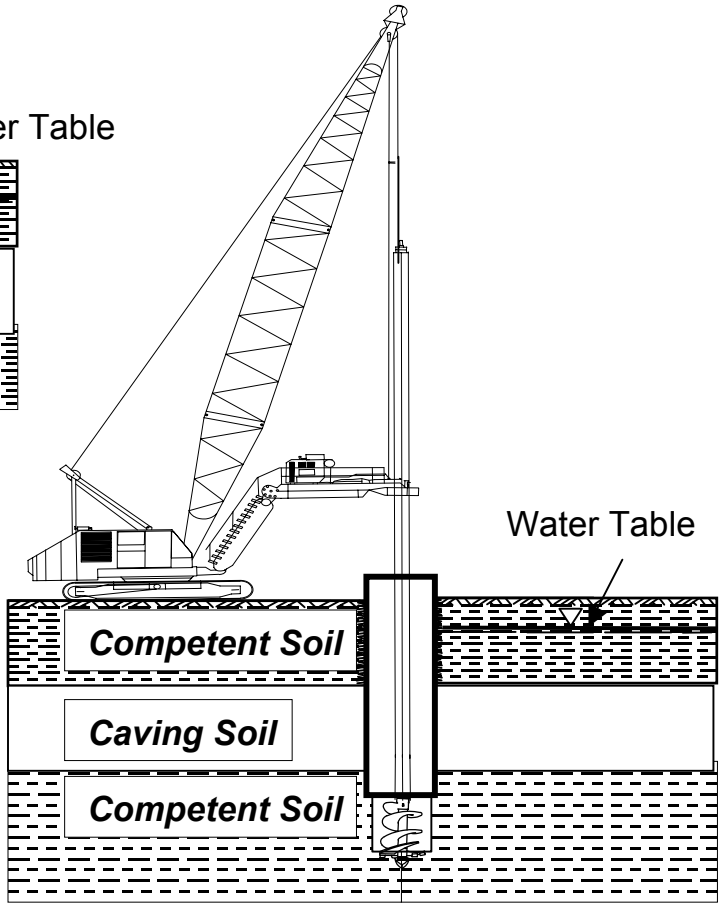


There are sites where the caving formation is a cohesionless soil beneath the water table, with a soft clay or rock below that stratum. An acceptable construction procedure that eliminates the need for slurry in such a case could be the driving of the casing with vibratory equipment, or with other pile-driving equipment, through the cohesionless soil into the impermeable geomaterial below.

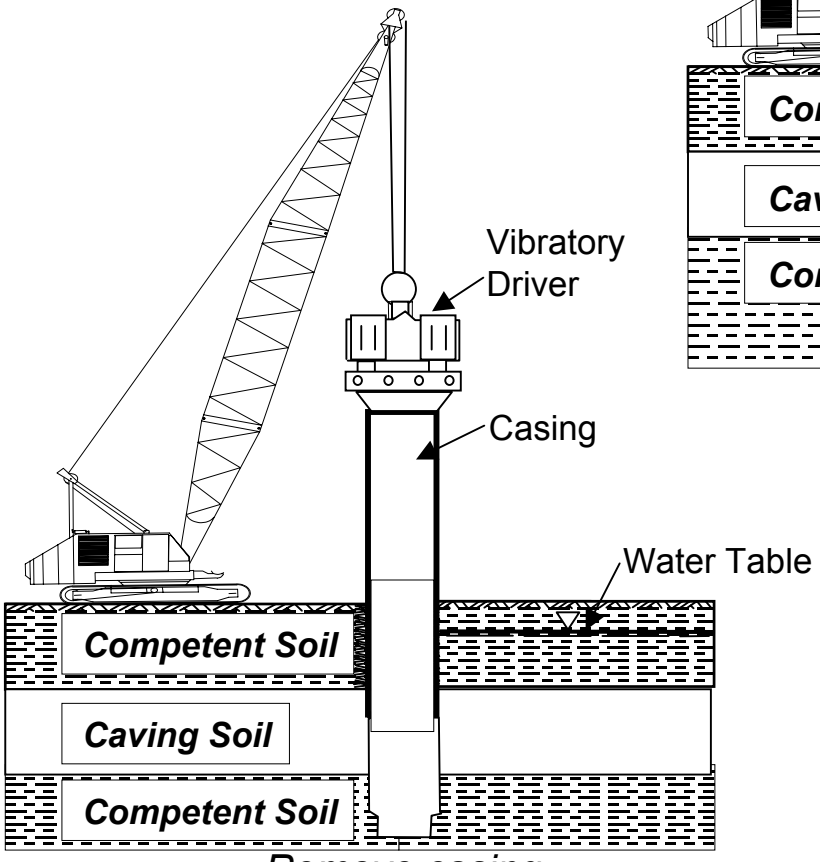
The use of special drilling rigs, sometimes termed "full-depth casing" rigs, that simultaneously excavate, rotate and push heavy-walled casing into place, keeping the base of the casing at or below the elevation of the excavating tool at all times. The casing on such rigs, which may be equipped with cutting teeth, actually helps make the excavation. These types of rigs have proved very successful in excavating soils with small boulders on occasion. They can also often be used where otherwise a wet drilling process would be required.



Installation of Casing

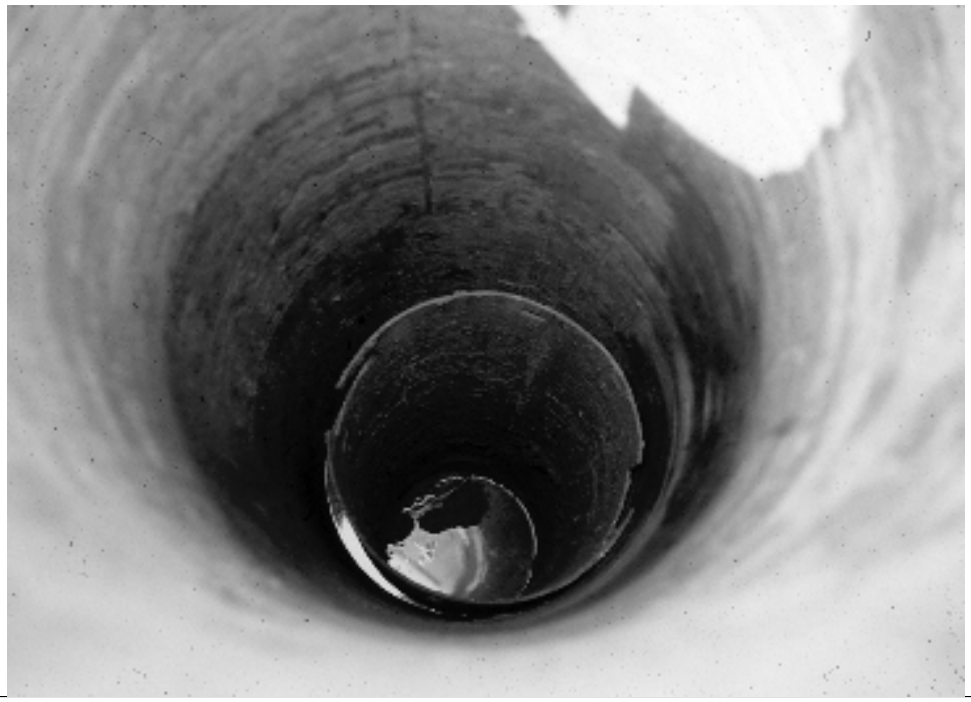


Drilling ahead of casing



Remove casing

TELESCOPING CASING



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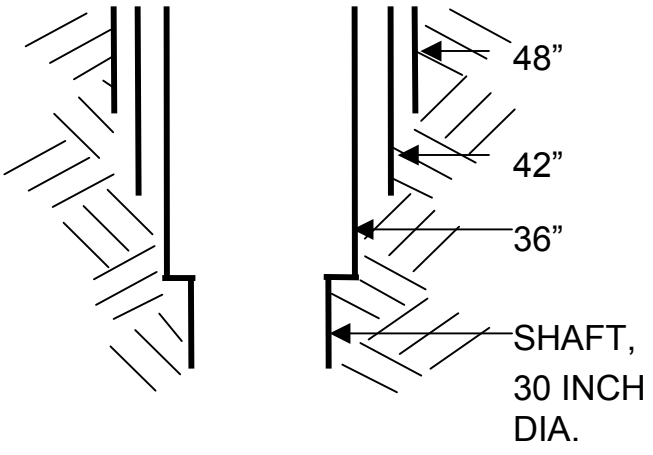
Casing often needs to be inserted into very deep boreholes and/or into very strong geomaterials, which may make it difficult to remove the casings. In such instances, contractors may choose to "telescope" the casing. That is, the first 10 or so feet will be excavated and a large-diameter casing sealed into the geomaterial at the bottom of the hole. A smaller-diameter borehole will then be advanced below the bottom of the casing, and a second casing, of smaller diameter than the first casing, will be sealed into the geomaterial at the bottom of the second-stage borehole. The process can be repeated several times to greater and greater depths until the plan base elevation is reached. With each step, the borehole diameter is reduced, usually by about 6 in. (152 mm). This procedure is often used where the geomaterial to be retained contains boulders.



LEARNING OBJECTIVE # 2

Describe the cased shaft construction method.

What are the two types of casing?

Name three uses for Permanent casing?

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LEARNING OBJECTIVE # 2

Describe the cased shaft construction method

Is slurry sometimes used in the Casing construction method?

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TYPICAL PROBLEMS

- Casing not “clean”
- Casing not sealed properly
- Poor concrete control
- Breaching of tremie

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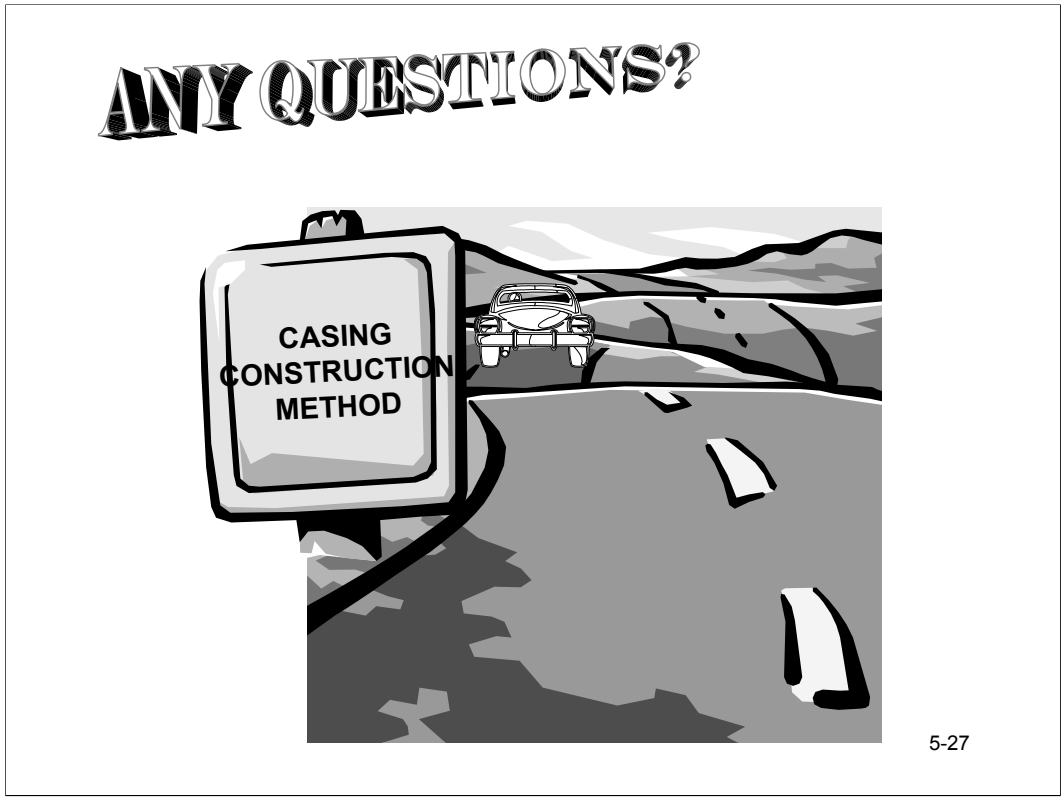
Temporary casing must be cleaned thoroughly after each use to have very low shearing resistance to the movement of fluid concrete. Casing with bonded concrete should not be allowed, because the bonded concrete will increase the shearing resistance between the casing and the column of fluid concrete placed inside the casing, and as the casing is lifted, it is possible that the column of concrete will be picked up, creating a neck or a void in the concrete, usually at the bottom of the casing, that will manifest itself as a defect in the completed drilled shaft. Obviously, the casing should be free of soil, lubricants and other deleterious material.

It is important that the casing be sealed in the impermeable formation so as to prevent the slurry from flowing beneath the casing.

If the concrete slump is too low, arching of the concrete will occur and the concrete will move up with the casing as it is pulled, thereby creating a gap for slurry to flow into. In addition, if the concrete mix design and time of placement are out of line, the concrete can start setting up and as the casing is pulled the same problem will occur.

Breaching (raising the bottom of the tremie above the concrete level) of the “tremie” results in a discontinuous placement, creating voids for slurry and sediment to contaminate the concrete.



Do you have any Questions?

LEARNING OBJECTIVES

- **Explain why casing is used in both dry and wet holes**
- **Describe the cased shaft construction process**
- **Describe typical construction problems associated with the use of casing**

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QUIZ

1. The Dry shaft method shall only be approved when the trial shaft demonstrates that less than _____ inches of water accumulates above the base over a one hour period when no pumping is permitted.

A. 4
B. 6
C. 8
D. 12

2. Wet shaft construction, which of the following is perhaps the most critical element in getting a good shaft?

A. A clean hole prior to casing
B. A clean hole prior to concreting
C. The use of temporary casing
D. A clean belling tool

3. Vibratory is one of the two forms of wet shaft construction.

True False

4. Which of the following describes soils most likely to create a problem with dry shaft construction?

A. Loose, cohesionless soils
B. Loose, fat clay
C. Dense, unfractured hard rock
D. Cohesive soils

5. Slurry is never used in the casing construction method.

True False

6. Of the following slurries, for which must the Contractor submit a detailed report signed by a qualified slurry consultant?

A. Polymer
B. Water
C. Blended
D. Mineral

7. The specified maximum sand content for polymer slurries at the base of the shaft just prior to concreting is ___?

A. 1%
B. 2%
C. 3%
D. 4%

8. The specified maximum sand content for mineral slurries at any time in the shaft is ___?

A. 1%
B. 2%
C. 3%
D. 4%

9. List the common slurry control tests.